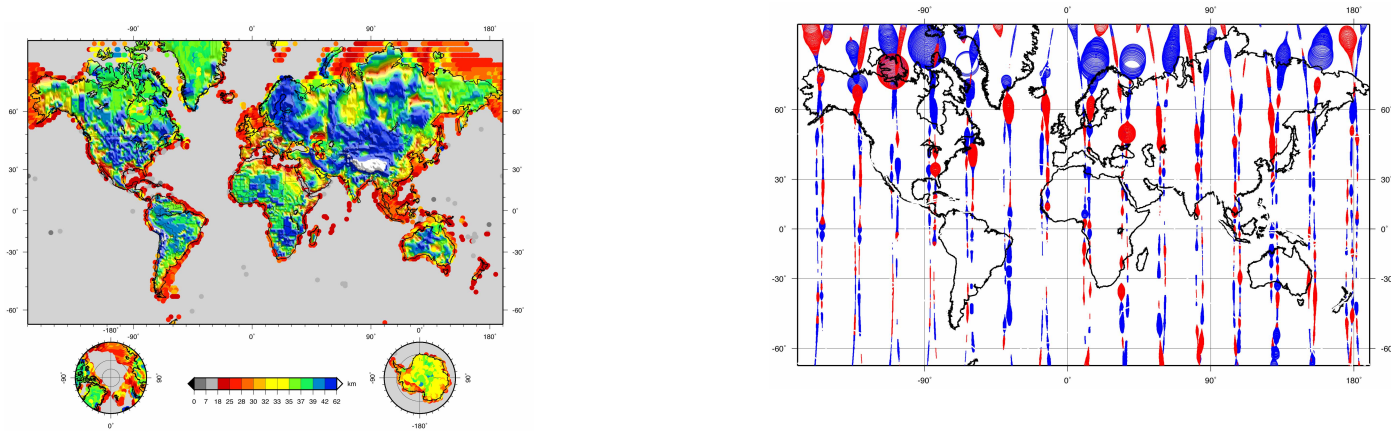


Estimating susceptibility and magnetization within the Earth's continental crust



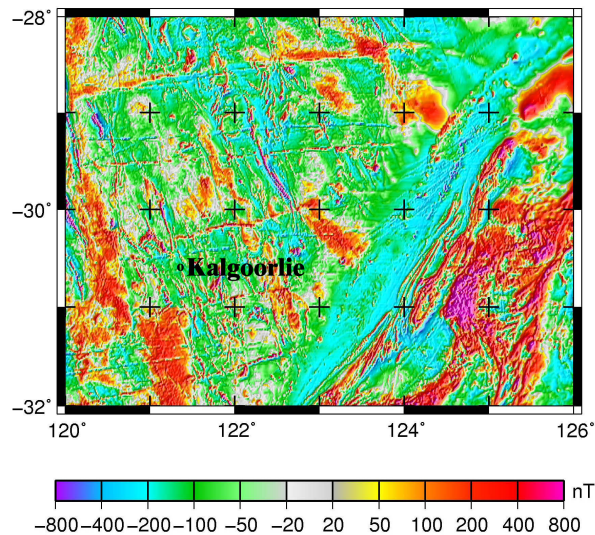
Michael Purucker (SGT at GSFC/NASA, USA) and
Suzanne McEnroe (NTNU, Norway) w.
contributions from Claire Bouligand (UJF-
Grenoble, France)

19 June 2014 Swarm Science team mtg.

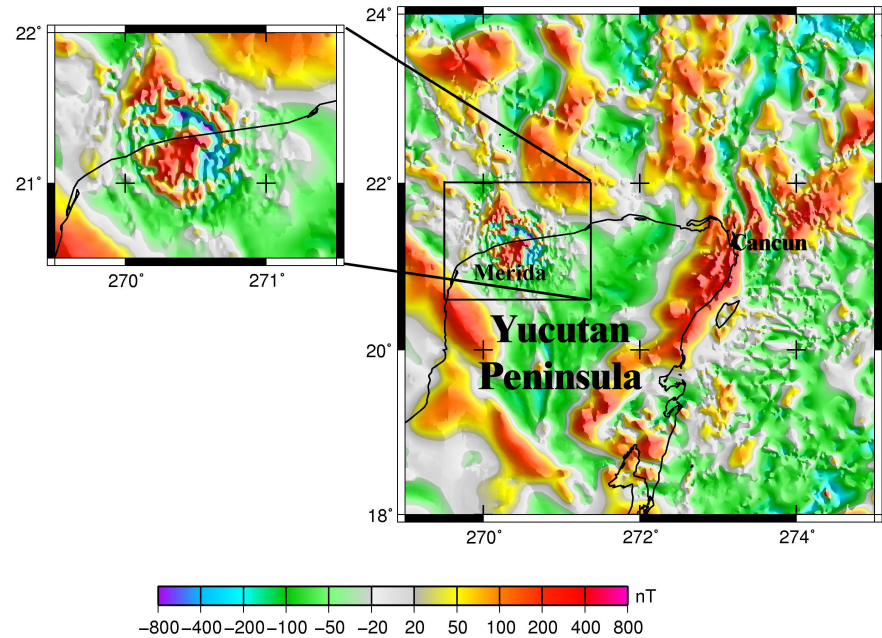
Outline

- Motivation and definition
- First Swarm gradients
- Polar magnetization bounds and interpretation
- Global susceptibility models, bounds, & interpretation
- Local susceptibility models and further comparisons
- Outlook

Uses of crustal magnetic field data



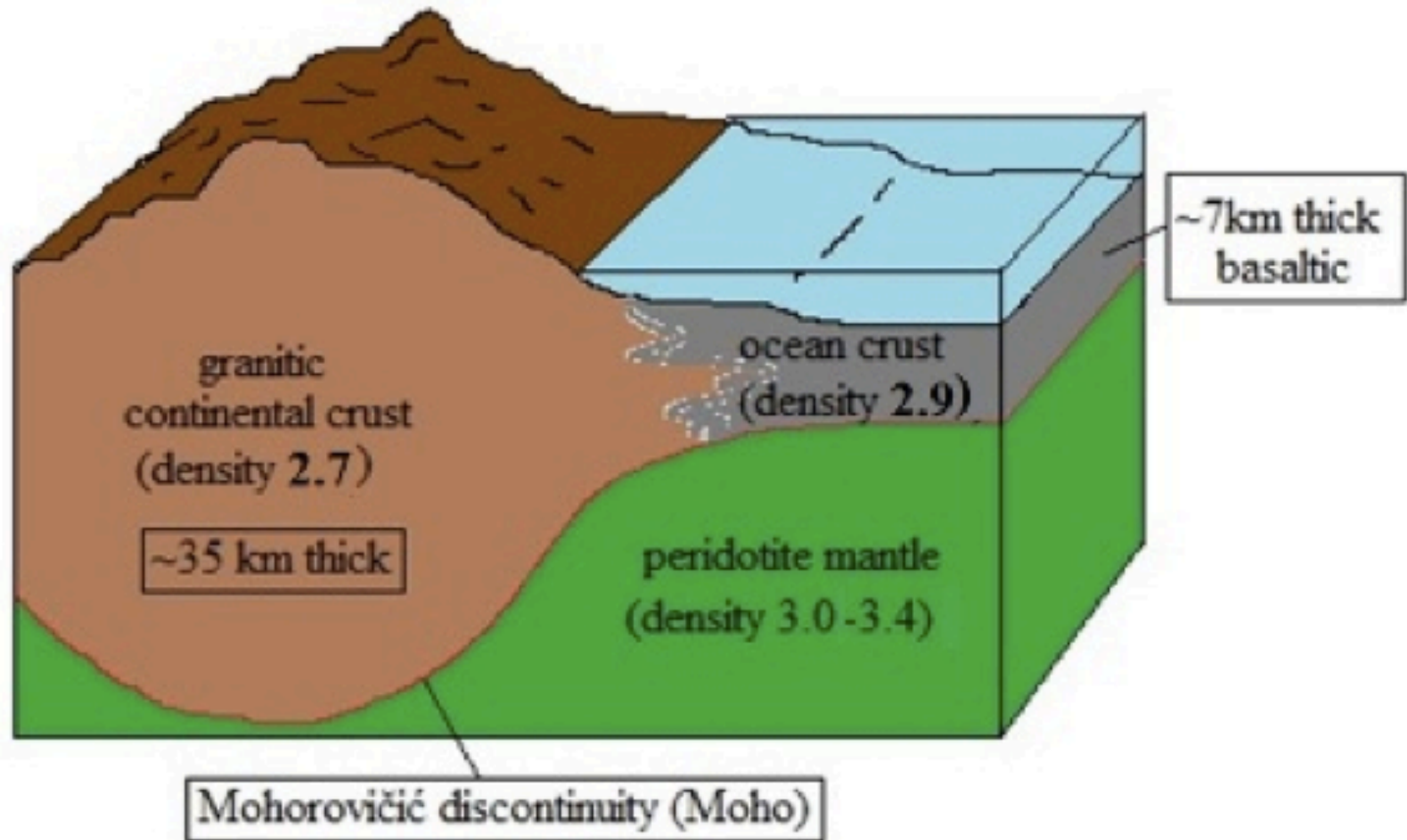
Australia: Mineral exploration



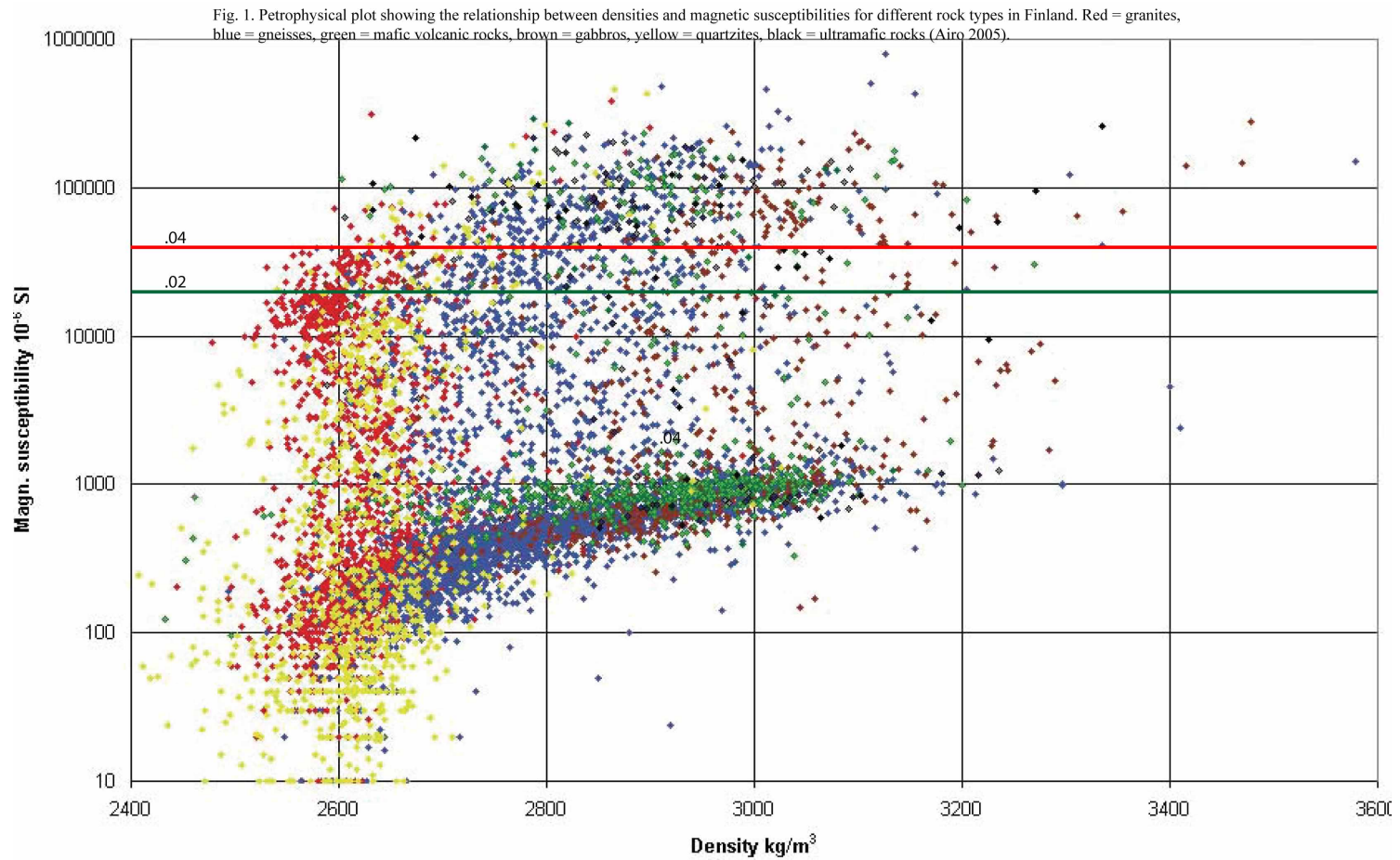
Mexico: Characterizing impacts

Purucker and Whaler, 2014

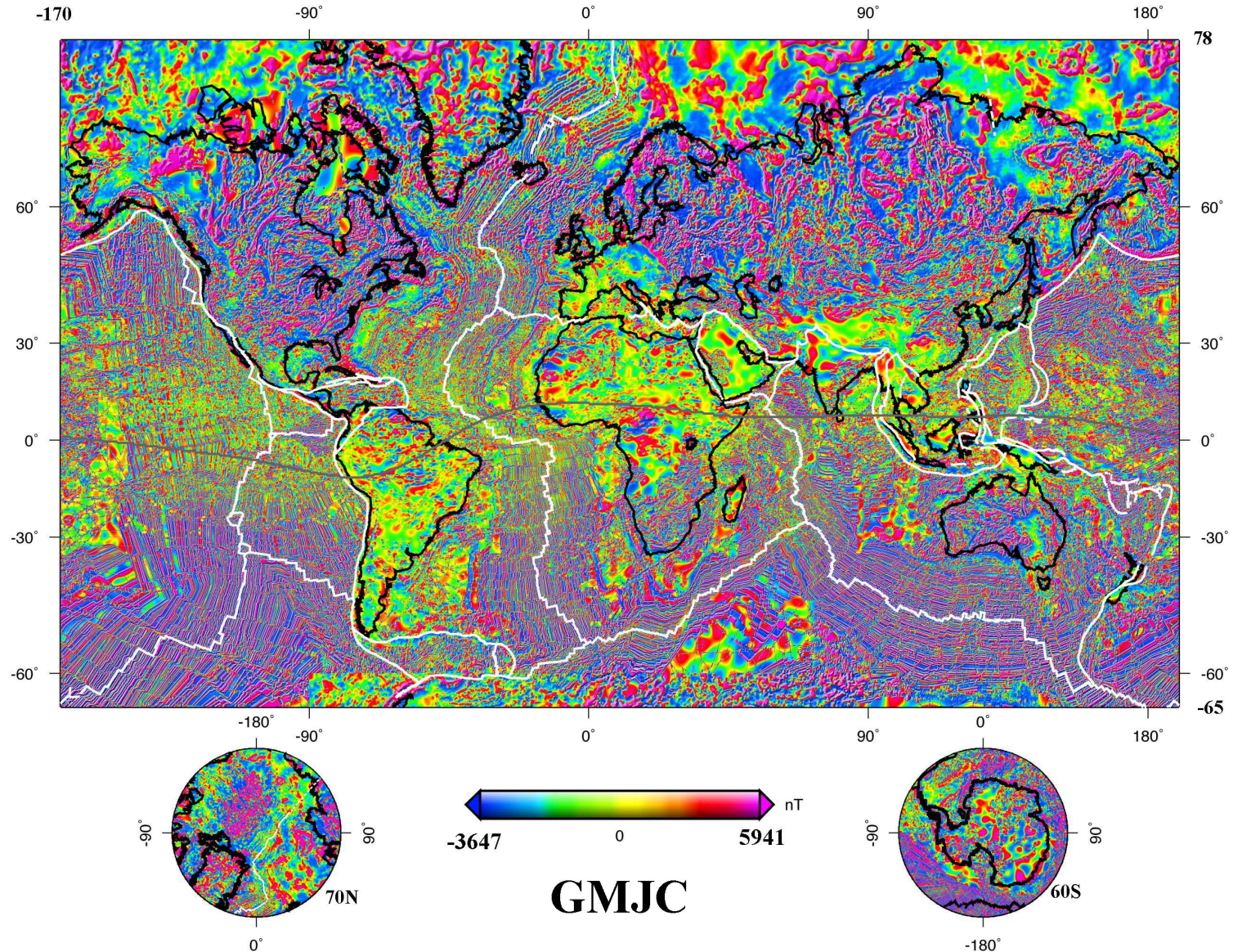
Magnetic field sources



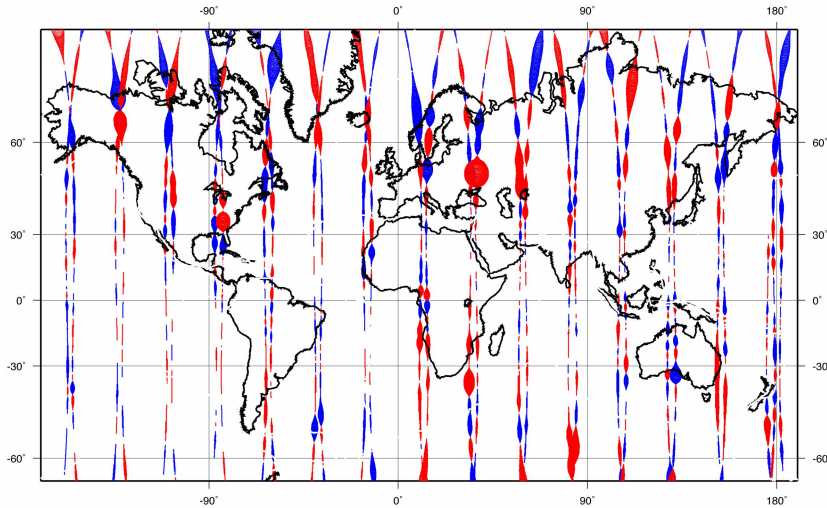
Magnetic susceptibility ranges



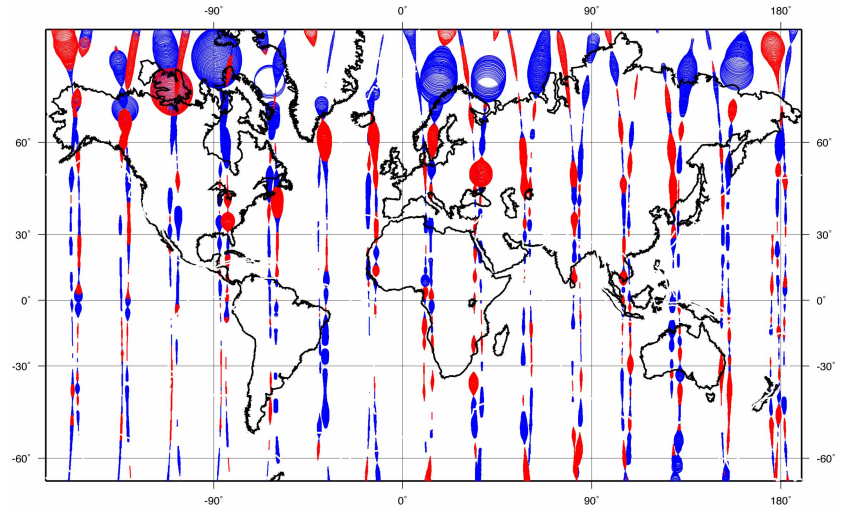
World Digital Magnetic Anomaly Map candidate



Swarm crustal gradients



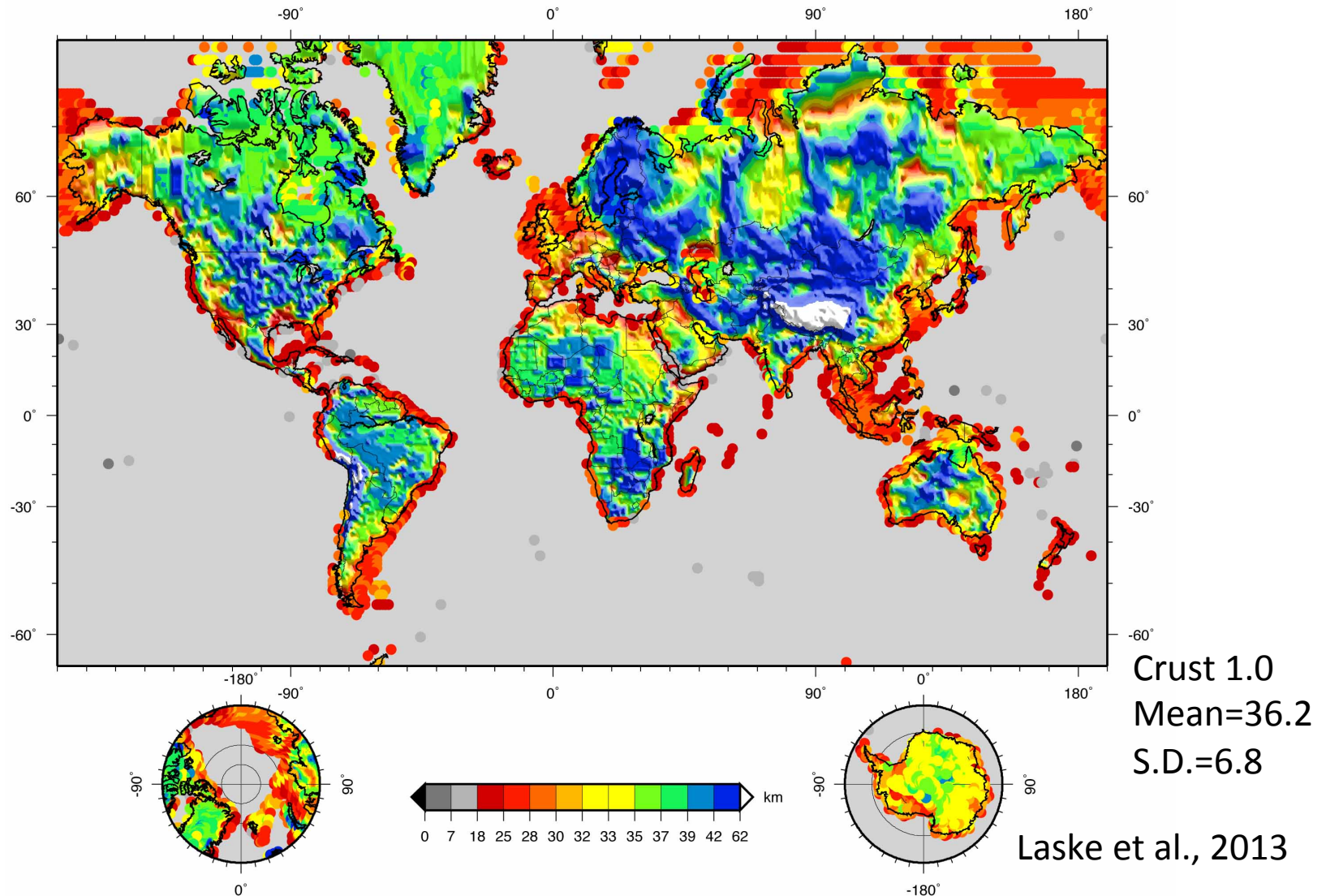
Model



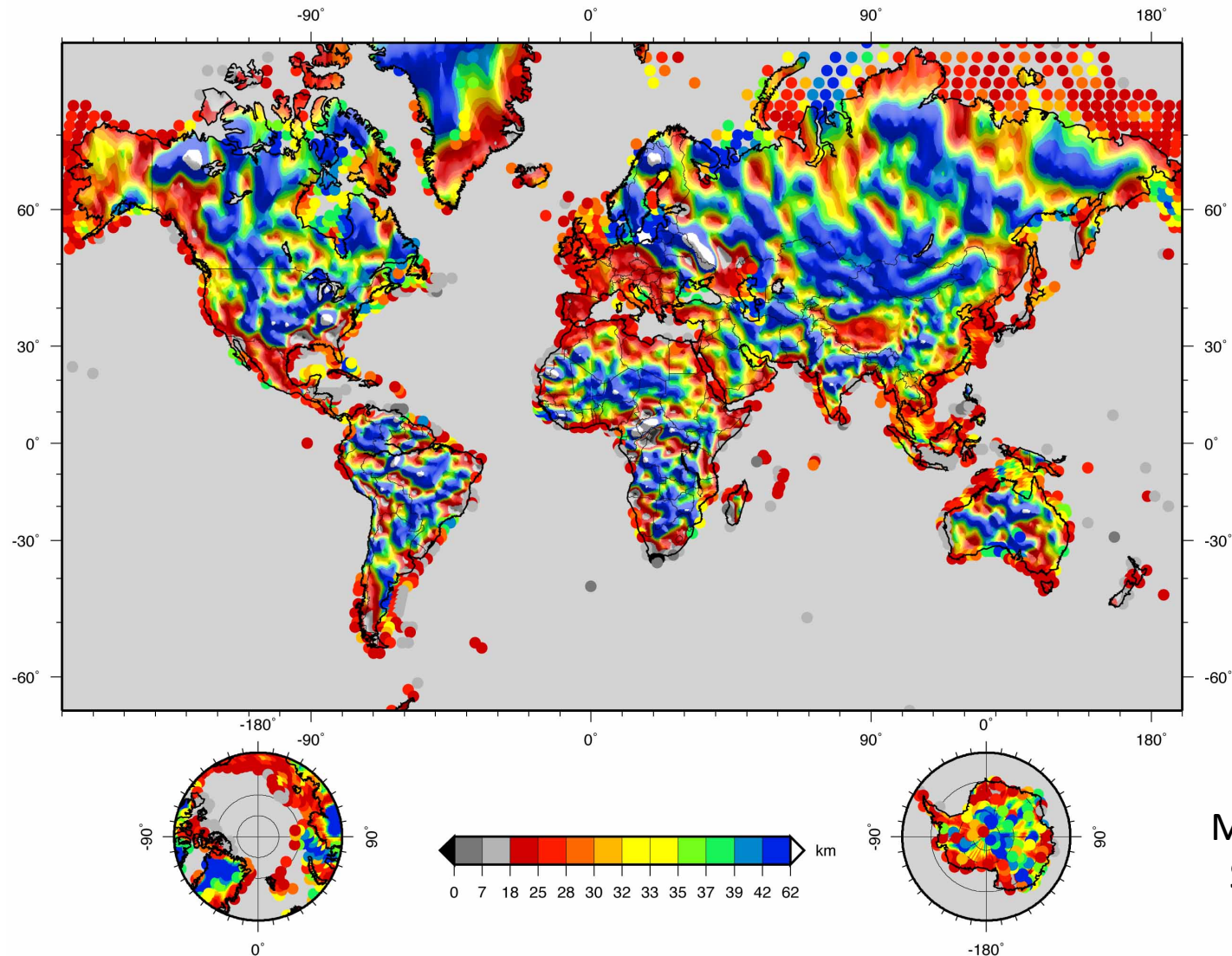
Observation

Swarm A-C gradients calculated from ASM (left), compared with crustal model (right), for 7 May. Chaos4p for removing main field model. Xchaos for crustal field model. $K_p < 0+$, 465 km altitude. All local times. Red (positive) gradients and Blue (negative) gradients. Typically $< |0.015 \text{ nT/km}|$

Starting seismic crustal crystalline thickness model

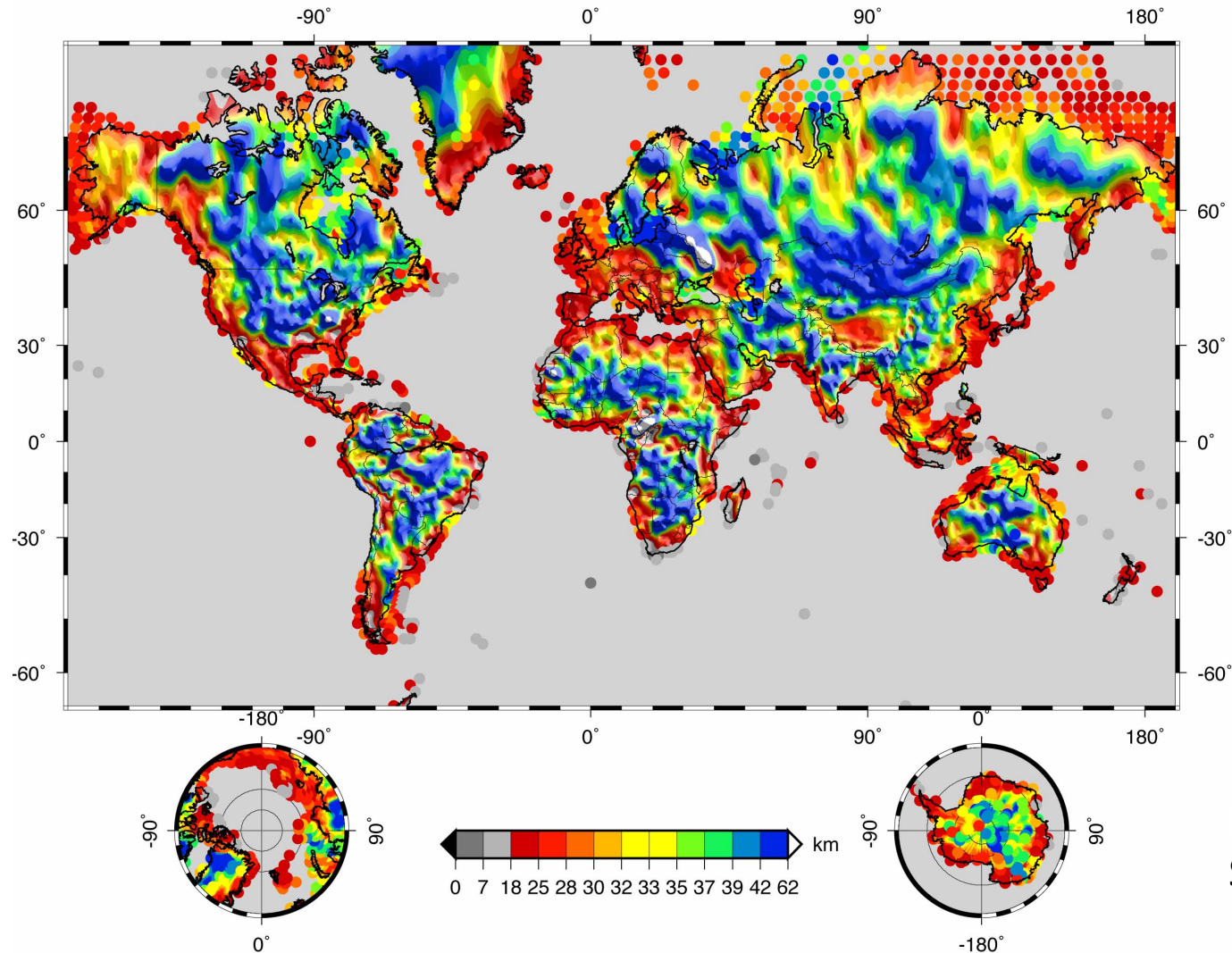


Global magnetic thickness model: $k=0.04$



Global magnetic thickness model

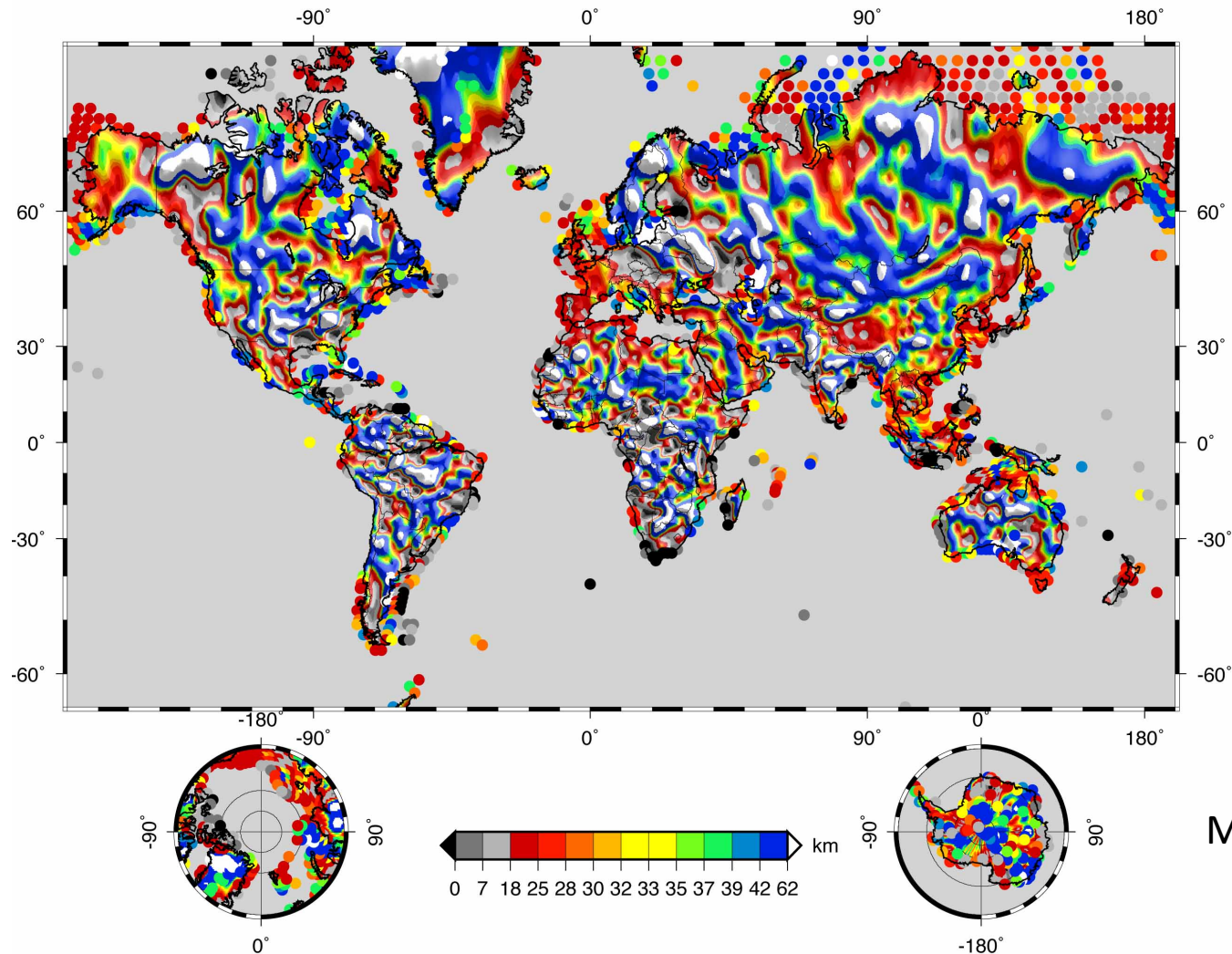
$k=0.06$



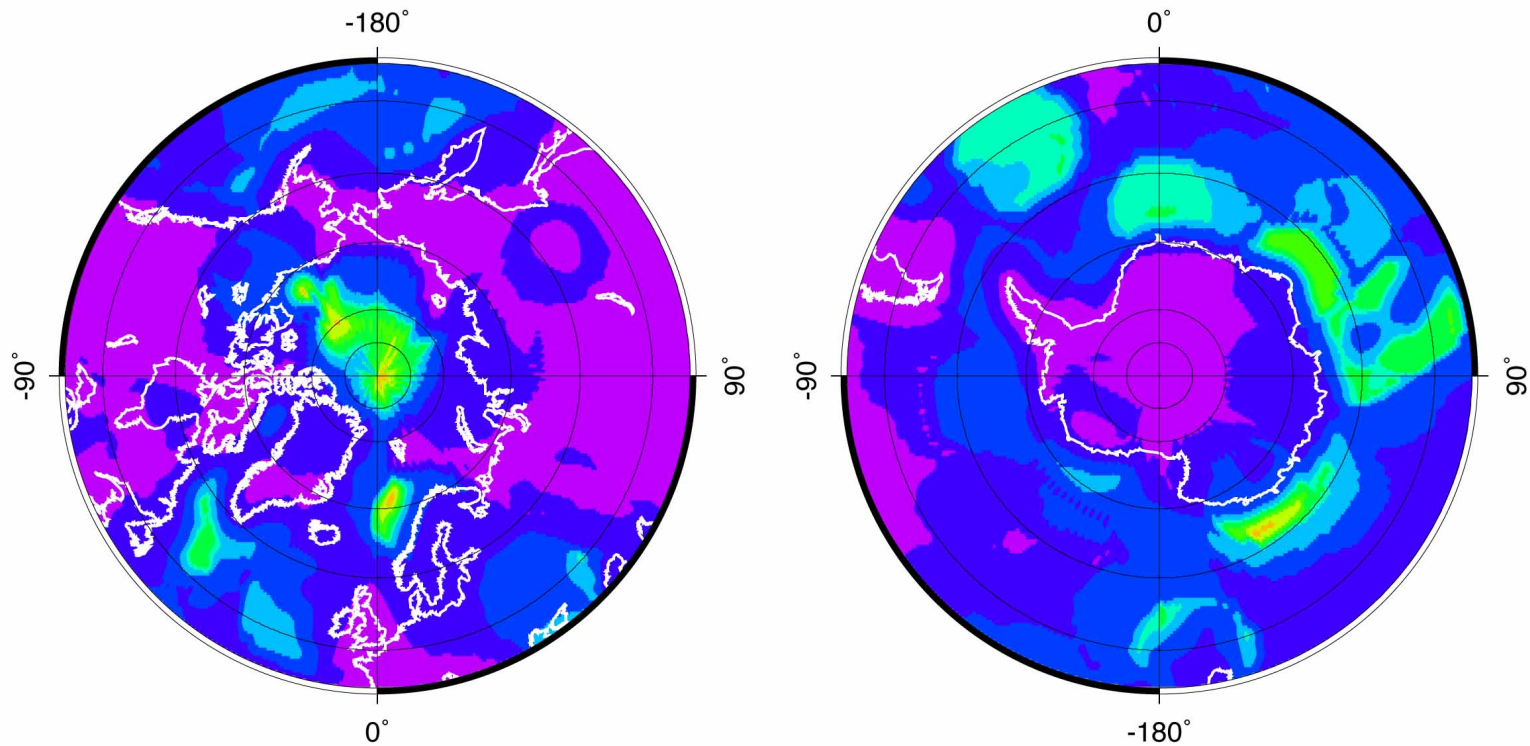
Mean=34.0
S.D.=9.1

Global magnetic thickness model

$k=0.02$



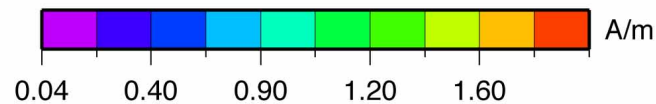
Minimum magnetization required, irrespective of direction



Crust 1.0

Xchaos

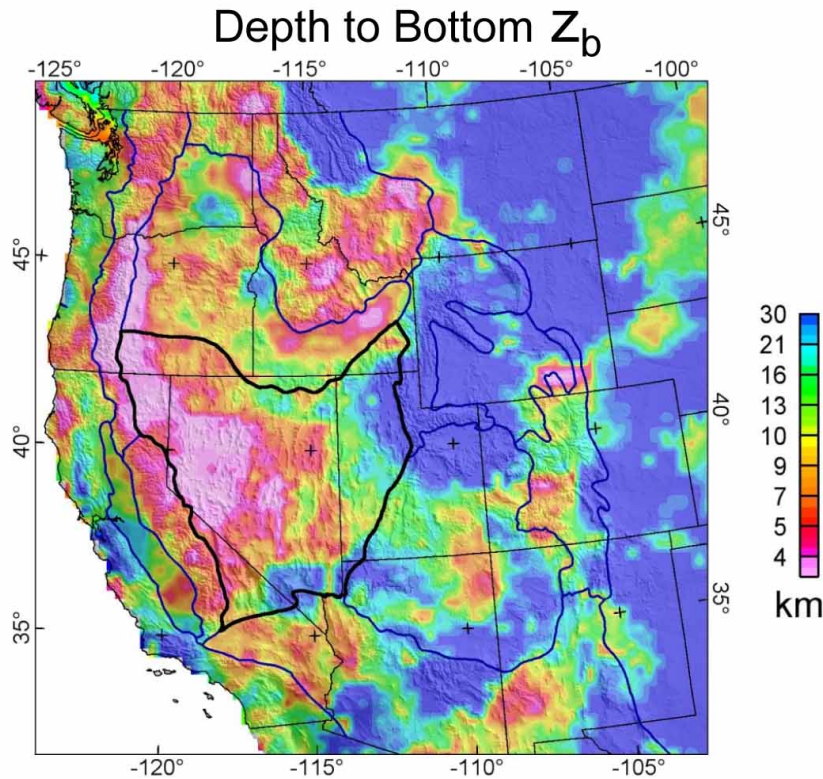
Parker, 2003, one
datum approach



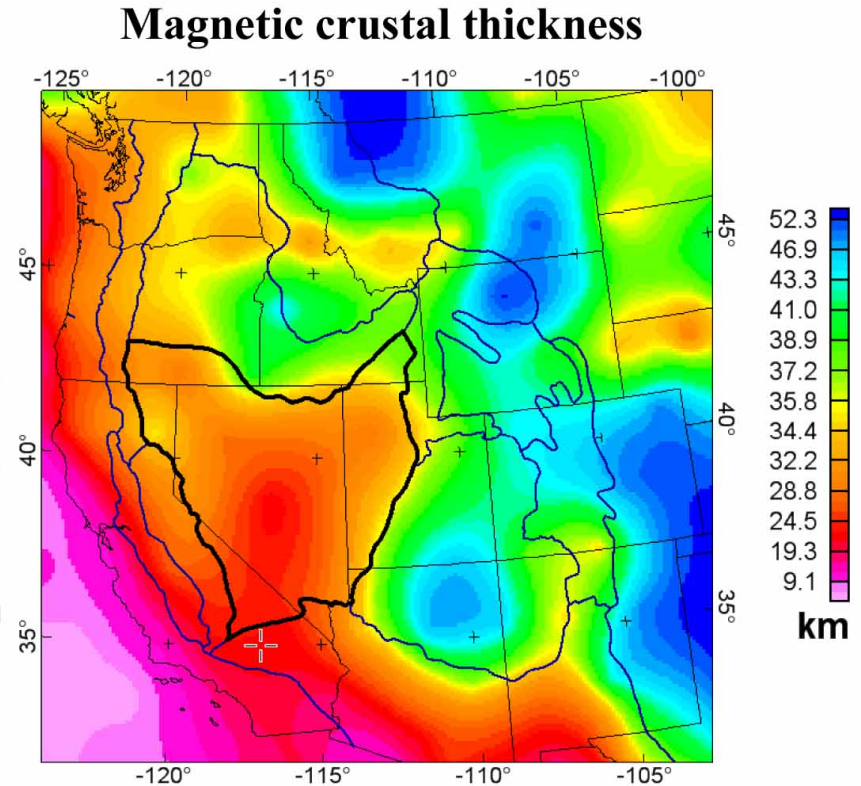
$$M \geq M_0 = \frac{12|B_z|/\mu_0}{[6 + \sqrt{3} \ln(2 + \sqrt{3})] \ln(h_2/h_1)}$$

B_z in an 800 km radius, h in 350 km radius

Local Model comparison



Modified from Bouligand et al., 2009



Modified from Purucker et al., 2007

Summary of results

- We have developed a series of new global and local models of the crustal magnetic field that can be used for interpretation.
- Near-surface rocks have, on average, magnetic susceptibilities that are too low to explain the magnetic features we see at satellite altitude.
- The discrepancy might be explained by remanent magnetization, or enhanced viscous remanent magnetization at depth, but conclusive experiments are lacking.
- Swarm will likely uncover more features with trends close to N-S because of its ability to map E-W gradients. This will have the effect of making the discrepancy between magnetic susceptibility measurements and spacecraft observations larger.